## Nigel - Mechatronic Design and Robust Sim2Real Control of an Over-Actuated Autonomous Vehicle

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## Abstract

Simulation to reality (sim2real) transfer from a dynamics and controls perspective usually involves re-tuning or adapting the designed algorithms to suit real-world operating conditions, which often violates the performance guarantees established originally. This work presents a generalizable framework for achieving reliable sim2real transfer of autonomy-oriented control systems using multi-model multi-objective robust optimal control synthesis, which lends well to uncertainty handling and disturbance rejection with theoretical guarantees. Particularly, this work is centered around a novel actuation-redundant scaled autonomous vehicle called Nigel, with independent all-wheel drive and independent all-wheel steering architecture, whose enhanced configuration space bodes well for robust control applications. To this end, we present the mechatronic design, dynamics modeling, parameter identification, and robust stabilizing as well as tracking control of Nigel using the proposed framework, with exhaustive experimentation and benchmarking in simulation as well as real-world settings.

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